* NOTICES *

Bibliography

---

(19) [Publication country] Japan Patent Office (JP)
(12) [Kind of official gazette] Open patent official report (A)
(11) [Publication No.] JP,2002-250341,A (P2002-250341A)
(43) [Date of Publication] September 6, Heisei 14 (2002. 9.6)
(54) [Title of the Invention] The oil-level depth measuring method of a fluid lubrication agent used for liquid bearing equipment and it
(51) [The 7th edition of International Patent Classification]

F16C 33/10
17/02
F16N 29/00
G01B 11/22
G01F 23/28

[FI]

F16C 33/10 Z
17/02 Z
F16N 29/00 E
G01B 11/22 Z
G01F 23/28 J

[Request for Examination] Un-asking.
[The number of claims] 6
[Mode of Application] OL
[Number of Pages] 7
(21) [Application number] Application for patent 2001-44369 (P2001-44369)
(22) [Filing date] February 21, Heisei 13 (2001. 2.21)
(71) [Applicant]
[Identification Number] 000005821
[Name] Matsushita Electric Industrial Co., Ltd.
[Address] 1006, Kadoma, Kadoma-shi, Osaka
(72) [Inventor(s)]
[Name] Hino Toshifumi
[Address] 8-1, Furujimmachi, Takamatsu-shi, Kagawa-ken Inside of Matsushita-Kotobuki Electronics Industries, Ltd.
(74) [Attorney]
[Identification Number] 100068087
[Patent Attorney]
[Name] Morimoto Yoshihiro
[Theme code (reference)]

2F014
2F065
3J011

[F term (reference)]

2F014 AA08 FA10
2F065 AA06 AA25 CC00 FF10 FF61 HH13 JJ03 JJ09 NN20 PP24 QQ25
3J011 AA07 BA02 BA04 BA06 BA08 DA02 EA04 JA02 KA02 KA03 MA01 MA24 PA03 RA01

[Translation done.]

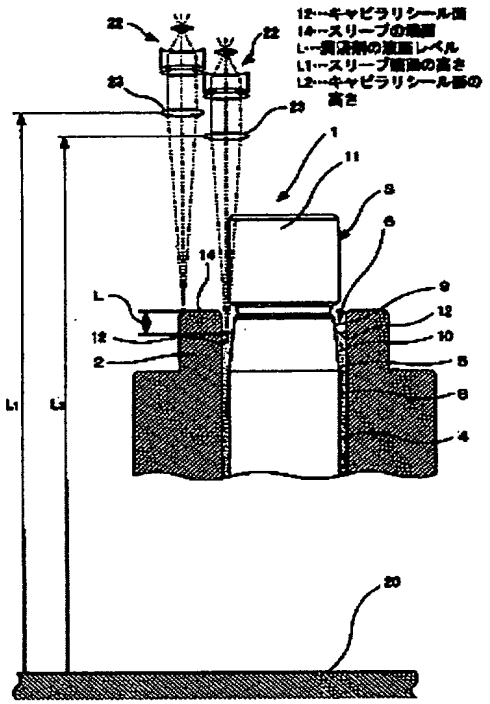
* NOTICES *

Epitome

---

(57) [Abstract]
[Technical problem] The volume of a fluid lubrication agent can be adjusted to a proper amount, and while being able to prevent the contamination of the air into the bearing by lack of a fluid lubrication agent, and printing of the bearing by friction, the oil-level depth measuring method of a fluid lubrication agent used for the liquid bearing equipment and it which can prevent the outflow by the excess of a fluid lubrication agent is offered.
[Means for Solution] In the liquid bearing equipment which was open for free passage in the minute annular gap 4 between a sleeve 2 and a shaft 3, formed the taper-like annular gap 10 in the opening 6 side of a sleeve 2, and was filled up with the lubricating oil 5 so that the oil level might be located in the taper-like annular gap 10, While doubling the focus of the lens section 23 of a microscope 22 with the end face 14 of a sleeve 2, the focus of said lens section 23 is doubled with the oil level of a lubricating oil 5, the distance from the end face 14 of a sleeve 2 to [from the difference of the height location of the lens section 23 in both] the oil level of a lubricating oil 5 is measured, and it asks for the oil-level depth of a lubricating oil 5.

[Translation done.]



[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] A sleeve and the shaft which formed and inserted the minute annular gap of predetermined spacing between this into this sleeve, In the liquid bearing equipment in which said shaft and said sleeve carry out a rotation drive relatively on the same axle through the fluid lubrication agent with which fluid lubrication agents with which said minute annular gap was filled up were consisted of, and said minute annular gap was filled up Liquid bearing equipment characterized by for the opening side having opened for free passage and formed in said minute annular gap the taper-like annular gap where spacing between said sleeves and said shafts is large at the opening side of said sleeve, and being filled up with said fluid lubrication agent so that the oil level may be located in said taper-like annular gap.
[Claim 2] Liquid bearing equipment according to claim 1 characterized by having cut the peripheral face of the shaft which countered the inner skin by the side of opening in said taper-like annular gap at said sleeve in the shape of a taper, and lacking and forming it.
[Claim 3] Liquid bearing equipment according to claim 1 characterized by having cut inner skin in the shape of a taper, and lacking and forming said taper-like annular gap in the opening side of said sleeve.
[Claim 4] Liquid bearing equipment according to claim 1 to 3 characterized by forming the outer diameter of this lobe in a minor diameter rather than the bore of said sleeve, and enabling it to check said taper-like annular gap by looking from an opening side while making it project from opening of said sleeve and inserting in said sleeve, in order to attach said shaft in housing.
[Claim 5] While doubling with the end face by the side of opening of said sleeve the focus of the lens section of an optical instrument characterized by providing the following From a difference with the height location of said lens section when the height location of said lens section when the focus of said lens section is doubled with the oil level of said fluid lubrication agent and the focus of said lens section suits the end face by the side of opening of said sleeve, and the focus of said lens section suit the oil level of said fluid lubrication agent The oil-level depth measuring method of the fluid lubrication agent in the liquid bearing equipment characterized by measuring the distance from the end face of said sleeve to the oil level of said fluid lubrication agent Sleeve The shaft which formed and inserted the minute annular gap of predetermined spacing between this into this sleeve So that said shaft and said sleeve may carry out a rotation drive relatively on the same axle through the fluid lubrication agent with which fluid lubrication agents with which said minute annular gap was filled up were consisted of, and said minute annular gap was filled up Nothing, And an opening side opens for free passage and forms in said minute annular gap the taper-like annular gap where spacing between said sleeves and said shafts is large at the opening side of said sleeve. In the liquid bearing equipment filled up with said fluid lubrication agent so that the oil level might be located in said taper-like annular gap, it faces measuring the oil-level depth of said fluid lubrication agent, and is the lens section.
[Claim 6] The oil-level depth measuring method of the fluid lubrication agent in the liquid bearing equipment according to claim 5 characterized by using a microscope as said optical instrument.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the oil-level depth measuring method of a fluid lubrication agent used for the liquid bearing equipment and it which are used suitable for spindle motors, such as information machines and equipment.
[0002]
[Description of the Prior Art] Conventionally, as liquid bearing equipment is shown, for example in JP,8-270653,A, the approach of filling up with a lubricating oil the minute gap formed in between in bearing (i.e., a sleeve and a shaft) is proposed using the vacuum pump.
[0003]
[Problem(s) to be Solved by the Invention] However, since it was difficult to check the volume of the lubricating oil with which it filled up in order to fill up the above minute gaps with a lubricating oil in liquid bearing equipment and the volume was not managed proper When there was little volume of a lubricating oil, the lubricating oil evaporated with the passage of time, volume decreased, air was involved in in bearing by the lack of a lubricating oil, and there was a possibility of having caused printing by friction and spoiling the function as a liquid bearing. On the other hand, when there is too much volume of a lubricating oil, and the operating environment becomes an elevated temperature, a lubricating oil expands and it flows into the exterior of bearing. The device attached in the spindle motor with which the liquid bearing was incorporated by it is polluted, and there is a problem of spoiling the function. For example, the fatal problem that a record medium (media) stuck to a head to the lubricating oil which flowed out in the magnetic recording medium was caused, and there was a problem of spoiling the original function as a magnetic recording medium.
[0004] Then, this invention can solve said technical problem and the volume of a fluid lubrication agent can be adjusted to a proper amount. While being able to prevent the contamination of the air into the bearing by lack of a fluid lubrication agent, and printing of the bearing by friction Let it be a technical problem to offer the oil-level depth measuring method of a fluid lubrication agent used for the liquid bearing equipment and it which can prevent the outflow by the excess of a fluid lubrication agent.
[0005]
[Means for Solving the Problem] In order to solve said technical problem, the liquid bearing equipment of this invention A sleeve and the shaft which formed and inserted the minute annular gap of predetermined spacing between this into this sleeve, In the liquid bearing equipment in which said shaft and said sleeve carry out a rotation drive relatively on the same axle through the fluid lubrication agent with which fluid lubrication agents with which said minute annular gap was filled up were consisted of, and said minute annular gap was filled up An opening side opens for free passage and forms in said minute annular gap the taper-like annular gap where spacing between said sleeves and said shafts is large at the opening side of said sleeve, and it is characterized by being filled up with said fluid lubrication agent so that the oil level may be located in said taper-like annular gap.
[0006] Since the taper-like annular gap was formed in the opening side of a sleeve, while according to said configuration capillarity is promoted, a fluid lubrication agent moves to a minute annular gap side certainly and a narrow cross section is filled up with it from the taper-like annular gap side of a large cross section, air etc. is not involved in into a fluid lubrication agent and the oil level which was maintained by capillarity and maintained by stability in the taper-like annular gap can be formed. And since the oil level maintained by capillarity can be maintained at stability, the volume of a fluid lubrication agent can be adjusted to a proper amount by adjusting the oil-level depth of a fluid lubrication agent.
[0007] Therefore, before building liquid bearing equipment into a spindle motor etc., by adjusting the volume of a fluid lubrication agent to a proper amount, it can involve in the air into the bearing by lack of a fluid lubrication agent, and the outflow by the seizure of the bearing by friction and the excess of a fluid lubrication agent can be prevented.

[0008] Moreover, invention indicated by claim 2 is characterized by having cut the peripheral face of the shaft which countered the sleeve in the taper-like annular gap at the inner skin by the side of opening in the shape of a taper, and lacking and forming it in said configuration.
[0009] According to said configuration, even if the centrifugal force by the rotation drive of a shaft acts on the fluid lubrication agent in a taper-like annular gap when making a sleeve rotate and carrying out [not to mention] the rotation drive of the shaft since the peripheral face of a shaft was cut in the shape of a taper and the taper-like annular gap was lacked and formed, it is prevented that a fluid lubrication agent disperses by the sleeve.
[0010] Moreover, invention indicated by claim 3 is characterized by having cut the inner skin by the side of opening of a sleeve in the shape of a taper, and lacking and forming a taper-like annular gap in said configuration.
[0011] According to said configuration, since the inner skin of a sleeve was cut in the shape of a taper and the taper-like annular gap was lacked and formed, said taper-like annular gap can be checked by looking from an opening side, it is easy to catch an oil level within the visual field of an optical instrument at the fluid lubrication agent maintained by capillarity, and the oil-level depth can be easily measured by the optical instrument.
[0012] Moreover, in said configuration, invention indicated by claim 4 is characterized by forming the outer diameter of this lobe in a minor diameter rather than the bore of said sleeve, and enabling it to check said taper-like annular gap by looking from an opening side while making it project from opening of a sleeve and inserting it in said sleeve, in order to attach a shaft in housing.
[0013] According to said configuration, since the outer diameter of a lobe was formed in the minor diameter rather than the bore of said sleeve, even if it makes a shaft project from opening of a sleeve, said taper annular gap can be checked by looking from an opening side, it is easy to catch the oil level of the fluid lubrication agent maintained by capillarity within the visual field of an optical instrument, and the oil-level depth can be easily measured by the optical instrument.
[0014] Furthermore, the oil-level depth measuring method of the fluid lubrication agent of this invention A sleeve and the shaft which formed and inserted the minute annular gap of predetermined spacing between this into this sleeve, So that said shaft and said sleeve may carry out a rotation drive relatively on the same axle through the fluid lubrication agent with which fluid lubrication agents with which said minute annular gap was filled up were consisted of, and said minute annular gap was filled up Nothing, And an opening side opens for free passage and forms in said minute annular gap the taper-like annular gap where spacing between said sleeves and said shafts is large at the opening side of said sleeve. In the liquid bearing equipment filled up with said fluid lubrication agent so that the oil level might be located in said taper-like annular gap While doubling with the end face by the side of opening of said sleeve the focus of the lens section of the optical instrument which faced measuring the oil-level depth of said fluid lubrication agent, and was equipped with the lens section From a difference with the height location of said lens section when the height location of said lens section when the focus of said lens section is doubled with the oil level of said fluid lubrication agent and the focus of said lens section suits the end face by the side of opening of said sleeve, and the focus of said lens section suit the oil level of said fluid lubrication agent It is characterized by measuring the distance from the end face of said sleeve to the oil level of said fluid lubrication agent.
[0015] While doubling the focus of the lens section of the optical instrument equipped with the lens section with the end face by the side of opening of said sleeve according to said configuration Since the focus of said lens section is doubled with the oil level of said fluid lubrication agent and the distance from the end face of said sleeve to [from the difference of the height location of the lens section in both] the oil level of said fluid lubrication agent is measured The oil-level depth of a fluid lubrication agent can be measured correctly, and the volume of a fluid lubrication agent can be easily managed in a proper amount.
[0016] Therefore, before building liquid bearing equipment into a spindle motor etc., by adjusting the volume of a fluid lubrication agent to a proper amount, it can involve in the air into the bearing by lack of a fluid lubrication agent, and the outflow by the seizure of the bearing by friction and the excess of a fluid lubrication agent can be prevented.
[0017] Moreover, invention indicated by claim 6 is characterized by using a microscope as an optical instrument in said configuration. According to said configuration, since a microscope is used as an optical instrument, the oil-level depth of a fluid lubrication agent can be measured simple and correctly.
[0018]
[Embodiment of the Invention] (Gestalt 1 of operation) The gestalt of implementation of invention indicated by claims 1, 2, and 4 is hereafter explained based on drawing 1 .

[0019] Drawing 1 is the sectional view showing the liquid bearing equipment in the gestalt of 1 operation of this invention. The shaft 3 which inserted liquid bearing equipment 1 into a sleeve 2 and this sleeve 2 in drawing 1 , It consists of lubricating oils (fluid lubrication agent) 5 with which the minute annular gap 4 formed between said sleeves 2 and shafts 3 was filled up. The lobe from the sleeve 2 of said shaft 3 is fixed to housing or the bracket of a spindle motor, through said lubricant 5, bearing support is carried out at a shaft 3, and a sleeve 2 carries out a rotation drive.

[0020] An end side carries out opening of said sleeve 2, opening 6 is formed, said minute annular gap 4 of predetermined spacing is formed between this in this sleeve 2, and said shaft 3 is inserted. The peripheral face 8 of the shaft 3 which counters the inner skin 7 by the side of the opening 6 of said sleeve 2 is cut in the shape of a taper, is lacked, the taper side 9 is formed, and as large the taper-like annular [spacing of a parenthesis] gap [as an opening 6 side] 10 where spacing between a sleeve 2 and a shaft 3 is larger than said minute annular gap 4 is opened for free passage and formed in said minute annular gap 4 of it at said opening 6 side. And it is formed more nearly up than said opening 6, and, as for the outer diameter D1 of a projection and this lobe 11, the lobe 11 for attaching in said shaft 3 at a spindle motor is formed in the minor diameter rather than the bore D2 of a sleeve 2.

[0021] In said configuration, a lubricating oil 5 is poured in into the taper-like annular gap 10 for example, by vacuum impregnation from opening 6. While filling up with the poured-in lubricating oil 5, without capillarity's being promoted by the taper-like annular gap 10 and including air etc. in the minute annular gap 4, it is formed in the taper-like annular gap 10, the oil level 12, i.e., the capillary sealing surface, of the lubricating oil 5 maintained by capillarity. The oil-level depth which this capillary sealing surface 12 was not changed and was stabilized is held. Therefore, the volume of a lubricating oil 5 can be adjusted to a proper amount by adjusting the oil-level depth of this capillary sealing surface 12. Moreover, since the taper side 9 was formed in the shaft 3 which does not carry out a rotation drive, there is no possibility that a lubricating oil 5 may disperse. Furthermore, since the outer diameter D1 of a lobe 11 was formed in the minor diameter rather than the bore D2 of a sleeve 2, when it is going to measure the oil-level depth of the capillary sealing surface 12 by an optical instrument etc., said capillary sealing surface 12 can be easily caught within the visual field of an optical instrument. Therefore, before building liquid bearing equipment 1 into a spindle motor, the outflow by the contamination of the air into the bearing by lack of a lubricating oil 5, the seizure of the bearing by friction, and the excess of a lubricating oil 5 can be prevented by adjusting the volume of a lubricating oil 5 to a proper amount.

[0022] Although the taper side 9 was formed in the shaft 3 which does not carry out a rotation drive with the gestalt of this operation, even if it may form the taper side 9 in a shaft 3 in the liquid bearing equipment 1 in which a shaft 3 carries out a rotation drive and the centrifugal force by the rotation drive of a shaft 3 acts on the lubricating oil 5 in the taper-like annular gap 10 in this case, it is prevented that a lubricating oil 5 disperses by the sleeve 2. Moreover, although the gestalt of this operation showed the liquid bearing equipment in which the end of a sleeve 2 carried out opening, what carried out opening is sufficient as both ends.

(Gestalt 2 of operation) Next, the gestalt of implementation of invention indicated by claim 3 is explained based on drawing 2 .

[0023] Drawing 2 is the sectional view showing the liquid bearing equipment in the gestalt of other operations of this invention. In addition, explanation of the matter and sign which were explained in the gestalt of said operation is omitted. In drawing 2 , liquid bearing equipment 1 cuts and lacks the inner skin 7 to a sleeve 2 at an opening 6 side, forms the taper side 13, and the taper-like annular gap 10 is formed, bearing support of the shaft 3 is carried out by it through a lubricating oil 5 at a sleeve 2, and it carries out a rotation drive by it.

[0024] According to said configuration, the capillary sealing surface 12 stabilized like the gestalt 1 of said operation can be formed. Furthermore, when it is going to measure the oil-level depth of the capillary sealing surface 12 by an optical instrument etc., said capillary sealing surface 12 can be easily caught within the visual field of an optical instrument.

(Gestalt 3 of operation) Next, the gestalt of implementation of invention indicated by claims 5 and 6 is explained based on drawing 3 - drawing 5 .

[0025] It is the partial enlarged drawing in which the schematic diagram and drawing 4 which show the oil-level depth measuring method of a fluid lubrication agent [in / in drawing 3 / the gestalt of operation of this invention] show an important section enlarged drawing to drawing 3 , and drawing 5 shows the oil-level depth. In addition, explanation of the matter and sign which were explained in the gestalt 1 of said operation is omitted.

[0026] Drawing 3 and drawing 4 show how to measure the oil-level depth of the lubricant used for it in the liquid bearing equipment shown in drawing 1 , liquid bearing equipment 1 is laid on susceptor 20, and the

microscope 22 which equipped the upper predetermined location of liquid bearing equipment 1 with the length measurement gage (height gage) 24 is arranged.
[0027] It faces measuring the oil-level depth of a lubricating oil 5, the initial valve position of the lens section 23 is first read according to the graduation of the length measurement gage 24 which makes the front face of susceptor 20 a datum plane for the height location of the lens section 23 of a microscope 22, and it is measured as elevation of the lens section 23.
[0028] Subsequently, move susceptor 20 in the direction of X-Y (horizontal) suitably, and the end face 14 of a sleeve 2 is located under the lens section 23 of a microscope 22. The lens section 23 is moved in the direction of the end face 14 of a sleeve 2 in the condition, a focus is doubled with the end face 14 of a sleeve 2, the height location of the lens section 23 when a focus suits is read with the length measurement gage 24, and the height L1 of the end face 14 of a sleeve 2 is measured.
[0029] Subsequently, susceptor 20 is moved in the direction of X, the opening 6 of a sleeve 2 is located under the lens section 23, the lens section 23 is moved in the direction of the capillary sealing surface 12 in the condition, a focus is doubled with the capillary sealing surface 12, the height location of the lens section 23 when a focus suits is read with the length measurement gage 24, and the height L2 of the capillary sealing surface 12 is measured.
[0030] And oil-level depth L of the lubricating oil 5 from the end face 14 of a sleeve 2 is calculated by the degree type from the value of the height L1 of the end face 14 of a sleeve 2, and the height L2 of the capillary sealing surface 12. That is, the oil-level depth of a lubricating oil 5 is called for from a difference with the height location of said lens section when the height location of said lens section when the focus of said lens section suits the end face by the side of opening of said sleeve, and the focus of said lens section suit the oil level of said fluid lubrication agent.
[0031] As it is more than oil-level depth =L1-L2 of a lubricating oil 5, since the oil-level depth of a lubricating oil 5 can be measured, it faces being filled up with a lubricating oil 5 to liquid bearing equipment 1. While setting an upper limit 32 as the oil-level depth in consideration of the oil-level depth 35 at the time of the oil-level depth 34 at the time of the expansion at the time of the elevated temperature of the lubricating oil 5 with which it is filled up, low temperature, or reduction by evaporation so that a lubricating oil 5 may not flow out beforehand at the time of an elevated temperature as shown in drawing 5 The minimum 33 of the oil-level depth is set up so that a life may not be shortened by reduction of the volume of the lubricating oil 5 by evaporation etc. and a vapor-liquid interface may not be formed in bearing at the time of low temperature, and the volume of a lubricating oil 5 is adjusted so that it may become the capillary sealing surface 12 of the predetermined oil-level depth by it.
[0032] According to said configuration, the oil-level depth of a lubricating oil 5 can be measured correctly, and the volume of the lubricating oil 5 with which liquid bearing equipment 1 is filled up can be adjusted to a proper amount. Therefore, before building liquid bearing equipment 1 into a spindle motor etc., the outflow by the contamination of the air into the bearing by lack of a lubricating oil 5, the seizure of the bearing by friction, and the excess of a lubricating oil 5 can be prevented by adjusting the volume of a lubricating oil 5.
[0033] Although asked by measuring the height from this datum plane to the end face 14 of a sleeve 2, and the height to the capillary sealing surface 12 by making into a datum plane the front face of susceptor 20 in which liquid bearing equipment 1 was laid in the oil-level depth of a lubricating oil 5 in the gestalt of this operation As long as it can measure the distance from the end face 14 of a sleeve 2 to the capillary sealing surface 12, you may ask by which approach.
[0034]
[Effect of the Invention] As mentioned above, according to the liquid bearing equipment of this invention, since the taper-like annular gap was formed in the opening side of a sleeve, the oil level of the fluid lubrication agent which was maintained by capillarity in the taper-like annular gap and was maintained at stability can be formed, and the volume of a fluid lubrication agent can be adjusted to a proper amount by adjusting the oil-level depth of a fluid lubrication agent.
[0035] Therefore, before building liquid bearing equipment into a spindle motor etc., the outflow by the contamination of the air into the bearing by lack of a fluid lubrication agent, the seizure of the bearing by friction, and the excess of a fluid lubrication agent can be prevented by adjusting the volume of a fluid lubrication agent to a proper amount.
[0036] Moreover, also when according to invention indicated by claim 2 carrying out the rotation drive of the sleeve and carrying out [not to mention] the rotation drive of the shaft, it is prevented that a fluid lubrication agent disperses by the sleeve.
[0037] Moreover, according to invention indicated by claim 3, it is easy to catch the oil level of the fluid

lubrication agent maintained by capillarity within the visual field of an optical instrument, and the oil-level depth can be easily measured by the optical instrument.
[0038] Moreover, according to invention indicated by claim 4, even if it makes a shaft project from opening of a sleeve, it is easy to catch the oil level of the fluid lubrication agent maintained by capillarity within the visual field of an optical instrument, and the oil-level depth can be easily measured by the optical instrument.
[0039] Furthermore, since the oil-level depth of a fluid lubrication agent is measured by the optical instrument equipped with the lens according to the oil-level depth measuring method of the fluid lubrication agent of this invention, the oil-level depth of a fluid lubrication agent can be measured correctly, and the volume of a fluid lubrication agent can be easily managed in a proper amount.
[0040] Therefore, before building liquid bearing equipment into a spindle motor etc., the outflow by the contamination of the air into the bearing by lack of a fluid lubrication agent, the seizure of the bearing by friction, and the excess of a fluid lubrication agent can be prevented by adjusting the volume of a fluid lubrication agent to a proper amount.
[0041] Moreover, according to invention indicated by claim 6, since a microscope is used as an optical instrument, the oil-level depth of a fluid lubrication agent can be measured simple and correctly.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the liquid bearing equipment in the gestalt of 1 operation of this invention.
[Drawing 2] It is the sectional view showing the liquid bearing equipment in the gestalt of other operations of this invention.
[Drawing 3] It is the schematic diagram showing the oil-level depth measuring method of the fluid lubrication agent in the gestalt of operation of this invention.
[Drawing 4] It is the important section enlarged drawing of drawing 3 .
[Drawing 5] It is the partial enlarged drawing which the oil-level depth shows.
[Description of Notations]
1 Liquid Bearing Equipment
2 Sleeve
3 Shaft
4 Minute Annular Gap
5 Lubricant
6 Opening
7 Inner Skin
8 Peripheral Face
9 Taper Side
10 Taper-like Annular Gap
11 Lobe
12 Capillary Sealing Surface
13 Taper Side
14 End Face of Sleeve
19 Ring-like Closure Member
20 Susceptor

22 Microscope
23 Lens Section
24 Length Measurement Gage
32 Upper Limit of Oil-Level Depth
33 Minimum of Oil-Level Depth
34 Oil-Level Depth at the Time of Expansion
35 Oil-Level Depth at the Time of Reduction
L The oil-level depth of a lubricating oil
L1 Height of a sleeve end face
L2 Height of a capillary sealing surface
X The migration direction of susceptor

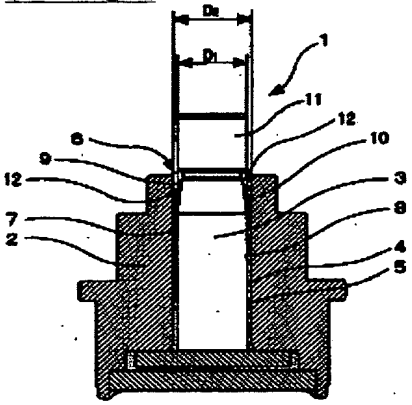
[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

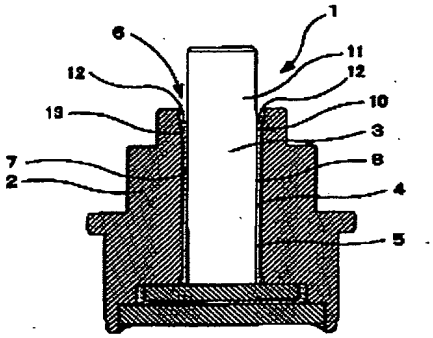
DRAWINGS

[Drawing 1]



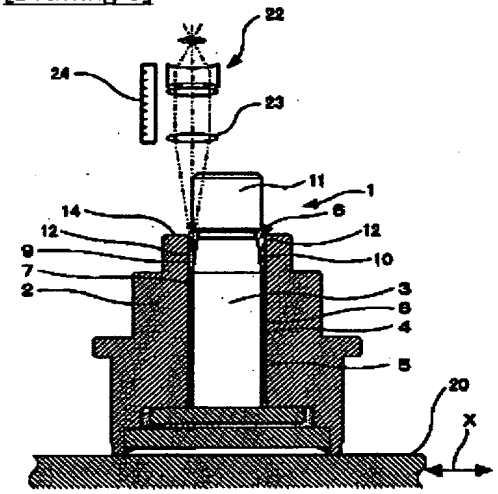
2…スリーブ
3…シャフト
4…動小環状間隙
5…潤滑油
6…スリーブの開口部
9…テーパ面
10…テーパ状環状間隙
12…キャピラリシール面

[Drawing 2]



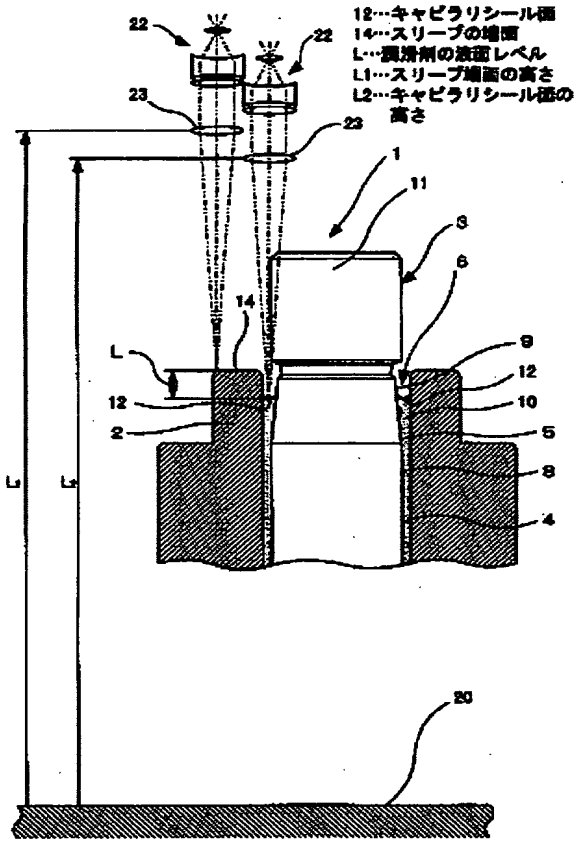
2…スリーブ
3…シャフト
4…微小環状間隙
5…潤滑油
6…スリーブの開口部
10…テーパ状環状間隙
12…キャピラリシール面
13…テーパ面

[Drawing 3]

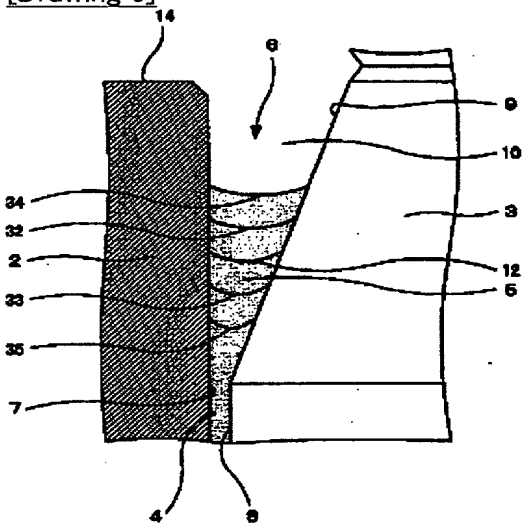


2…スリーブ
3…シャフト
4…微小環状間隙
5…潤滑油
10…テーパ状環状間隙
12…キャピラリシール面
14…スリーブの端面
22…観察光
23…レンズ部
24…測長ゲージ

[Drawing 4]



[Drawing 5]



12…キャビラリシール面
32…液面レベルの上限
33…液面レベルの下限

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2002－250341
（Ｐ２００２－２５０３４１Ａ）
(43)公開日　平成14年９月６日(2002.9.6)

(51)Int.Cl.[7]	識別記号	Ｆ Ｉ		テーマコード（参考）
F16C 33/10		F16C 33/10	Z	2F014
17/02		17/02	Z	2F065
F16N 29/00		F16N 29/00	E	3J011
G01B 11/22		G01B 11/22	Z	
G01F 23/28		G01F 23/28	J	

審査請求　未請求　請求項の数６　ＯＬ　（全７頁）

(21)出願番号　特願2001－44369(Ｐ2001－44369)

(22)出願日　平成13年２月21日(2001.2.21)

(71)出願人　000005821
松下電器産業株式会社
大阪府門真市大字門真1006番地

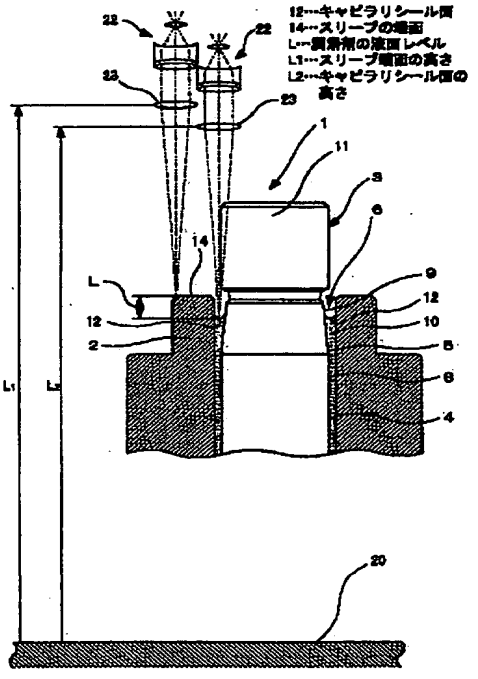
(72)発明者　日野　利文
香川県高松市古新町８番地の１　松下寿電子工業株式会社内

(74)代理人　100068087
弁理士　森本　義弘

最終頁に続く

(54)【発明の名称】流体軸受装置及びそれに用いる液体潤滑剤の液面深さ測定方法

(57)【要約】
【課題】　液体潤滑剤の液量を適正な量に調整することができて、液体潤滑剤の不足による軸受内への空気の巻き込み及び摩擦による軸受の焼き付きを防止することができるとともに液体潤滑剤の過多による流出を防止することができる流体軸受装置及びそれに用いる液体潤滑剤の液面深さ測定方法を提供する。
【解決手段】　スリーブ２の開口部６側に、スリーブ２とシャフト３との間の微小環状間隙４に連通してテーパ状環状間隙１０を形成し、潤滑油５をその液面がテーパ状環状間隙１０内に位置するように充填した流体軸受装置において、顕微鏡２２のレンズ部２３の焦点をスリーブ２の端面１４に合わせるとともに、前記レンズ部２３の焦点を潤滑油５の液面に合わせ、両者におけるレンズ部２３の高さ位置の差から、スリーブ２の端面１４から潤滑油５の液面までの距離を測定して、潤滑油５の液面深さを求める。



1

【特許請求の範囲】

【請求項１】　スリーブと、このスリーブ内にこれとの間に所定間隔の微小環状間隙を形成して挿入したシャフトと、前記微小環状間隙に充填した液体潤滑剤とから構成され、前記微小環状間隙に充填した液体潤滑剤を介して前記シャフトと前記スリーブとが同軸上で相対的に回転駆動する流体軸受装置において、前記スリーブの開口部側に、開口部側ほど前記スリーブと前記シャフトとの間の間隔が大きいテーパ状環状間隙を前記微小環状間隙に連通して形成し、前記液体潤滑剤をその液面が前記テーパ状環状間隙内に位置するように充填したことを特徴とする流体軸受装置。

【請求項２】　前記テーパ状環状間隙を、前記スリーブに開口部側の内周面に対向したシャフトの外周面をテーパ状に切り欠いて形成したことを特徴とする請求項１記載の流体軸受装置。

【請求項３】　前記テーパ状環状間隙を、前記スリーブの開口部側に内周面をテーパ状に切り欠いて形成したことを特徴とする請求項１記載の流体軸受装置。

【請求項４】　前記シャフトをハウジングに取り付けるために前記スリーブの開口部から突出させて前記スリーブに挿入するとともに、この突出部の外径を前記スリーブの内径よりも小径に形成して開口部側から前記テーパ状環状間隙を視認し得るようにしたことを特徴とする請求項１～請求項３のいずれかに記載の流体軸受装置。

【請求項５】　スリーブと、このスリーブ内にこれとの間に所定間隔の微小環状間隙を形成して挿入したシャフトと、前記微小環状間隙に充填した液体潤滑剤とから構成され、前記微小環状間隙に充填した液体潤滑剤を介して前記シャフトと前記スリーブとが同軸上で相対的に回転駆動するようになし、かつ前記スリーブの開口部側に、開口部側ほど前記スリーブと前記シャフトとの間の間隔が大きいテーパ状環状間隙を前記微小環状間隙に連通して形成し、前記液体潤滑剤をその液面が前記テーパ状環状間隙内に位置するように充填した流体軸受装置において、前記液体潤滑剤の液面深さを測定するに際し、レンズ部を備えた光学機器のレンズ部の焦点を前記スリーブの開口部側の端面に合わせるとともに、前記レンズ部の焦点を前記液体潤滑剤の液面に合わせ、前記レンズ部の焦点が前記スリーブの開口部側の端面に合ったときの前記レンズ部の高さ位置と前記レンズ部の焦点が前記液体潤滑剤の液面に合ったときの前記レンズ部の高さ位置との差から、前記スリーブの端面から前記液体潤滑剤の液面までの距離を測定することを特徴とする流体軸受装置における液体潤滑剤の液面深さ測定方法。

【請求項６】　前記光学機器として顕微鏡を用いることを特徴とする請求項５記載の流体軸受装置における液体潤滑剤の液面深さ測定方法。

【発明の詳細な説明】

【０００１】

2

【発明の属する技術分野】本発明は、情報機器などのスピンドルモータに好適に使用される流体軸受装置及びそれに用いる液体潤滑剤の液面深さ測定方法に関するものである。

【０００２】

【従来の技術】従来、流体軸受装置においては、例えば特開平８－２７０６５３号公報に示すように、真空ポンプを利用して潤滑油を軸受内すなわちスリーブとシャフトとの間に形成された微小間隙に充填する方法が提案されている。

【０００３】

【発明が解決しようとする課題】しかし、流体軸受装置においては前記のような微小間隙に潤滑油を充填するため充填された潤滑油の液量を確認することが困難であって、その液量が適正に管理されていなかったために、潤滑油の液量が少ない場合には時間の経過とともに潤滑油が蒸発して液量が減少し、潤滑油不足により、軸受内に空気が巻き込まれたり、摩擦による焼き付きを起こして流体軸受としての機能を損なうおそれがあった。一方、潤滑油の液量が多過ぎる場合には、その使用環境が高温になった時に潤滑油が膨張して軸受の外部に流出し、それによって流体軸受が組み込まれたスピンドルモータに取り付けた機器が汚染されてその機能を損なうという問題があり、例えば磁気記録装置においては流出した潤滑油によって記録媒体（メディア）がヘッドに張り付くという致命的な問題を引き起こし、磁気記録装置としての本来の機能を損なうという問題があった。

【０００４】そこで、本発明は、前記課題を解決するものであって、液体潤滑剤の液量を適正な量に調整することができて、液体潤滑剤の不足による軸受内への空気の巻き込み及び摩擦による軸受の焼き付きを防止することができるとともに液体潤滑剤の過多による流出を防止することができる液体軸受装置及びそれに用いる液体潤滑剤の液面深さ測定方法を提供することを課題とするものである。

【０００５】

【課題を解決するための手段】前記課題を解決するために、本発明の流体軸受装置は、スリーブと、このスリーブ内にこれとの間に所定間隔の微小環状間隙を形成して挿入したシャフトと、前記微小環状間隙に充填した液体潤滑剤とから構成され、前記微小環状間隙に充填した液体潤滑剤を介して前記シャフトと前記スリーブとが同軸上で相対的に回転駆動する流体軸受装置において、前記スリーブの開口部側に、開口部側ほど前記スリーブと前記シャフトとの間の間隔が大きいテーパ状環状間隙を前記微小環状間隙に連通して形成し、前記液体潤滑剤をその液面が前記テーパ状環状間隙内に位置するように充填したことを特徴とするものである。

【０００６】前記構成によれば、スリーブの開口部側にテーパ状環状間隙を形成したので、毛細管現象が促進さ

れて液体潤滑剤が広い断面のテーパ状環状間隙側から狭い断面に微小環状間隙側へ確実に移動して充填されるとともに、液体潤滑剤中に空気などが巻き込まれることがなく、テーパ状環状間隙内に毛細管現象によって維持され安定に保たれた液面を形成することができる。そして、毛細管現象によって維持された液面を安定に保つことができることから、液体潤滑剤の液面深さを調節することによって、液体潤滑剤の液量を適正な量に調整することができる。

【０００７】したがって、流体軸受装置をスピンドルモータなどに組み込む前に、液体潤滑剤の液量を適正な量に調整することによって、液体潤滑剤の不足による軸受内への空気に巻き込み、摩擦による軸受の焼き付き及び液体潤滑剤の過多による流出を防止することができる。

【０００８】また、請求項２に記載された発明は、前記構成において、テーパ状環状間隙を、スリーブに開口部側の内周面に対向したシャフトの外周面をテーパ状に切り欠いて形成したことを特徴とするものである。

【０００９】前記構成によれば、テーパ状環状間隙をシャフトの外周面をテーパ状に切り欠いて形成したので、スリーブを回転運動させる場合は勿論のこと、シャフトを回転駆動させる場合にテーパ状環状間隙内の液体潤滑剤にシャフトの回転駆動による遠心力が作用しても、スリーブによって液体潤滑剤が飛散することが防止される。

【００１０】また、請求項３に記載された発明は、前記構成において、テーパ状環状間隙を、スリーブの開口部側の内周面をテーパ状に切り欠いて形成したことを特徴とするものである。

【００１１】前記構成によれば、テーパ状環状間隙をスリーブの内周面をテーパ状に切り欠いて形成したので、開口部側から前記テーパ状環状間隙を視認することができて、毛細管現象によって維持された液体潤滑剤に液面を光学機器の視野に捕らえ易く、光学機器によってその液面深さを容易に測定することができる。

【００１２】また、請求項４に記載された発明は、前記構成において、シャフトをハウジングに取り付けるためにスリーブの開口部から突出させて前記スリーブに挿入するとともに、この突出部の外径を前記スリーブの内径よりも小径に形成して開口部側から前記テーパ状環状間隙を視認し得るようにしたことを特徴とするものである。

【００１３】前記構成によれば、突出部の外径を前記スリーブの内径よりも小径に形成したので、シャフトをスリーブの開口部から突出させても、開口部側から前記テーパ環状間隙を視認することができて、毛細管現象によって維持された液体潤滑剤の液面を光学機器の視野に捕らえ易く、光学機器によってその液面深さを容易に測定することができる。

【００１４】さらに、本発明の液体潤滑剤の液面深さ測定方法は、スリーブと、このスリーブ内にこれとの間に所定間隔の微小環状間隙を形成して挿入したシャフトと、前記微小環状間隙に充填した液体潤滑剤とから構成され、前記微小環状間隙に充填した液体潤滑剤を介して前記シャフトと前記スリーブとが同軸上で相対的に回転駆動するようになし、かつ前記スリーブの開口部側に、開口部側ほど前記スリーブと前記シャフトとの間の間隔が大きいテーパ状環状間隙を前記微小環状間隙に連通して形成し、前記液体潤滑剤をその液面が前記テーパ状環状間隙内に位置するように充填した流体軸受装置において、前記液体潤滑剤の液面深さを測定するに際し、レンズ部を備えた光学機器のレンズ部の焦点を前記スリーブの開口部側の端面に合わせるとともに、前記レンズ部の焦点を前記液体潤滑剤の液面に合わせ、前記レンズ部の焦点が前記スリーブの開口部側の端面に合ったときの前記レンズ部の高さ位置と前記レンズ部の焦点が前記液体潤滑剤の液面に合ったときの前記レンズ部の高さ位置との差から、前記スリーブの端面から前記液体潤滑剤の液面までの距離を測定することを特徴とするものである。

【００１５】前記構成によれば、レンズ部を備えた光学機器のレンズ部の焦点を前記スリーブの開口部側の端面に合わせるとともに、前記レンズ部の焦点を前記液体潤滑剤の液面に合わせ、両者におけるレンズ部の高さ位置の差から、前記スリーブの端面から前記液体潤滑剤の液面までの距離を測定するので、液体潤滑剤の液面深さを正確に測定することができ、液体潤滑剤の液量を容易に適正な量に管理することができる。

【００１６】したがって、流体軸受装置をスピンドルモータなどに組み込む前に、液体潤滑剤の液量を適正な量に調整することによって、液体潤滑剤の不足による軸受内への空気に巻き込み、摩擦による軸受の焼き付き及び液体潤滑剤の過多による流出を防止することができる。

【００１７】また、請求項６に記載された発明は、前記構成において、光学機器として顕微鏡を用いることを特徴とするものである。前記構成によれば、光学機器として顕微鏡を用いるので、簡便かつ正確に液体潤滑剤の液面深さを測定することができる。

【００１８】

【発明の実施の形態】（実施の形態１）以下、請求項１、２及び４に記載された発明の実施の形態を図１に基づいて説明する。

【００１９】図１は本発明の一実施の形態における流体軸受装置を示す断面図である。図１において、流体軸受装置１はスリーブ２と、このスリーブ２内に挿入したシャフト３と、前記スリーブ２とシャフト３との間に形成された微小環状間隙４に充填した潤滑油（液体潤滑剤）５とから構成され、前記シャフト３のスリーブ２からの突出部がスピンドルモータのハウジング又はブラケットに固定され、スリーブ２が前記潤滑剤５を介してシャフト３に軸受支持されて回転駆動するものである。

5

【００２０】前記スリーブ２は一端側が開口して開口部６が形成され、このスリーブ２内にはこれとの間に所定間隔の前記微小環状間隙４を形成して前記シャフト３が挿入されている。前記スリーブ２の開口部６側の内周面７に対向するシャフト３の外周面８をテーパ状に切り欠いてテーパ面９を形成し、それによって前記開口部６側に前記微小環状間隙４よりもスリーブ２とシャフト３との間の間隔が大きくかつこの間隔が開口部６側ほど大きいテーパ状環状間隙１０が前記微小環状間隙４に連通して形成されている。そして、前記シャフト３にはスピンドルモータに取り付けるための突出部１１が前記開口部６よりも上方に突出し、この突出部１１の外径D_1はスリーブ２の内径D_2よりも小径に形成されている。

【００２１】前記構成において、潤滑油５を開口部６から例えば真空注入によってテーパ状環状間隙１０内に注入する。注入された潤滑油５は、テーパ状環状間隙１０によって毛細管現象が促進されて、微小環状間隙４に空気などを含むことなく充填されるとともに、テーパ状環状間隙１０内に毛細管現象によって維持された潤滑油５の液面すなわちキャピラリシール面１２が形成される。このキャピラリシール面１２は変動することがなく、安定した液面深さが保持される。したがって、このキャピラリシール面１２の液面深さを調節することによって、潤滑油５の液量を適正な量に調整することができる。また、回転駆動しないシャフト３にテーパ面９を形成したので、潤滑油５が飛散するおそれはない。さらに、突出部１１の外径D_1をスリーブ２の内径D_2よりも小径に形成したので、キャピラリシール面１２の液面深さを光学機器などによって測定しようとするときに、前記キャピラリシール面１２を光学機器の視野に容易に捕らえることができる。したがって、流体軸受装置１をスピンドルモータに組み込む前に、潤滑油５の液量を適正な量に調整することによって、潤滑油５の不足による軸受内への空気の巻き込み、摩擦による軸受の焼き付き及び潤滑油５の過多による流出を防止することができる。

【００２２】本実施の形態では、回転駆動しないシャフト３にテーパ面９を形成したが、シャフト３が回転駆動する流体軸受装置１においてシャフト３にテーパ面９を形成してもよく、この場合にはテーパ状環状間隙１０内の潤滑油５にシャフト３の回転駆動による遠心力が作用しても、スリーブ２によって潤滑油５が飛散することが防止される。また、本実施の形態ではスリーブ２の一端が開口した流体軸受装置を示したが、両端が開口したものでもよい。

（実施の形態２）次に、請求項３に記載された発明の実施の形態を図２に基づいて説明する。

【００２３】図２は本発明の他実施の形態における流体軸受装置を示す断面図である。なお、前記実施の形態において説明した事項及び符号の説明は省略する。図２において、流体軸受装置１は、スリーブ２にその内周面７

6

を開口部６側において切り欠いてテーパ面１３を形成し、それによってテーパ状環状間隙１０を形成したものであって、シャフト３が潤滑油５を介してスリーブ２に軸受支持されて回転駆動するものである。

【００２４】前記構成によれば、前記実施の形態１と同様に安定したキャピラリシール面１２を形成することができる。さらに、キャピラリシール面１２の液面深さを光学機器などによって測定しようとするときに、前記キャピラリシール面１２を光学機器の視野に容易に捕らえることができる。

（実施の形態３）次に、請求項５及び６に記載された発明の実施の形態を図３～図５に基づいて説明する。

【００２５】図３は本発明の実施の形態における液体潤滑剤の液面深さ測定方法を示す概略図、図４は図３に要部拡大図、図５は液面深さを示す部分拡大図である。なお、前記実施の形態１において説明した事項及び符号の説明は省略する。

【００２６】図３、図４は図１に示した流体軸受装置においてそれに用いる潤滑剤の液面深さを測定する方法を示すものであって、流体軸受装置１が支持台２０の上に載置され、流体軸受装置１の上方の所定位置に、測長ゲージ（ハイトゲージ）２４を備えた顕微鏡２２が配置されている。

【００２７】潤滑油５の液面深さを測定するに際しては、まず、顕微鏡２２のレンズ部２３の高さ位置を、支持台２０の表面を基準面とする測長ゲージ２４の目盛に合わせてレンズ部２３の初期位置を読み取り、それをレンズ部２３の基準面からの高さとして測定する。

【００２８】次いで、支持台２０をＸ－Ｙ方向（水平方向）へ適宜移動してスリーブ２の端面１４を顕微鏡２２のレンズ部２３の下方に位置させ、その状態でレンズ部２３をスリーブ２の端面１４の方向に移動させて焦点をスリーブ２の端面１４に合わせ、焦点が合ったときのレンズ部２３の高さ位置を測長ゲージ２４にて読み取って、スリーブ２の端面１４の高さL_1を測定する。

【００２９】次いで、支持台２０をＸ方向へ移動してスリーブ２の開口部６をレンズ部２３の下方に位置させ、その状態でレンズ部２３をキャピラリシール面１２の方向に移動させて焦点をキャピラリシール面１２に合わせ、焦点が合ったときのレンズ部２３の高さ位置を測長ゲージ２４にて読み取って、キャピラリシール面１２の高さL_2を測定する。

【００３０】そして、スリーブ２の端面１４の高さL_1とキャピラリシール面１２の高さL_2の値から次式によってスリーブ２の端面１４からの潤滑油５の液面深さＬを求める。すなわち、潤滑油５の液面深さは、前記レンズ部の焦点が前記スリーブの開口部側の端面に合ったときの前記レンズ部の高さ位置と前記レンズ部の焦点が前記液体潤滑剤の液面に合ったときの前記レンズ部の高さ位置との差から求められる。

【００３１】潤滑油５の液面深さ＝L_1-L_2

以上のようにして潤滑油５の液面深さを測定できることから、流体軸受装置１へ潤滑油５を充填するに際しては、図５に示すように、充填する潤滑油５の高温時における膨張時の液面深さ３４、低温時又は蒸発による減少時の液面深さ３５を考慮して、予め高温時に潤滑油５が流出しないように液面深さに上限３２を設定するとともに、蒸発などによる潤滑油５の液量の減少によって寿命が短縮されずかつ低温時に軸受内に気液境界面が形成されないように液面深さの下限３３を設定し、それによって所定の液面深さのキャピラリシール面１２になるように潤滑油５の液量を調整する。

【００３２】前記構成によれば、潤滑油５の液面深さを正確に測定することができ、流体軸受装置１に充填する潤滑油５の液量を適正な量に調整することができる。したがって、流体軸受装置１をスピンドルモータなどに組み込む前に、潤滑油５の液量を調整することによって、潤滑油５の不足による軸受内への空気の巻き込み、摩擦による軸受の焼き付き及び潤滑油５の過多による流出を防止することができる。

【００３３】本実施の形態においては、潤滑油５の液面深さを、流体軸受装置１が載置された支持台２０の表面を基準面とすることによって、この基準面からスリーブ２の端面１４までの高さ及びキャピラリシール面１２までの高さを測定することによって求めたが、スリーブ２の端面１４からキャピラリシール面１２までの距離を測定することができれば、いずれの方法で求めてもよい。

【００３４】

【発明の効果】以上のように、本発明の流体軸受装置によれば、スリーブの開口部側にテーパ状環状間隙を形成したので、テーパ状環状間隙に毛細管現象によって維持され安定に保たれた液体潤滑剤の液面を形成することができ、液体潤滑剤の液面深さを調節することによって、液体潤滑剤の液量を適正な量に調整することができる。

【００３５】したがって、流体軸受装置をスピンドルモータなどに組み込む前に、液体潤滑剤の液量を適正な量に調整することによって、液体潤滑剤の不足による軸受内への空気の巻き込み、摩擦による軸受の焼き付き及び液体潤滑剤の過多による流出を防止することができる。

【００３６】また、請求項２に記載された発明によれば、スリーブを回転駆動させる場合は勿論のこと、シャフトを回転駆動させる場合にも、スリーブによって液体潤滑剤が飛散することが防止される。

【００３７】また、請求項３に記載された発明によれば、毛細管現象によって維持された液体潤滑剤の液面を光学機器の視野に捕らえ易く、光学機器によってその液面深さを容易に測定することができる。

【００３８】また、請求項４に記載された発明によれば、シャフトをスリーブの開口部から突出させても、毛細管現象によって維持された液体潤滑剤の液面を光学機器の視野に捕らえ易く、光学機器によってその液面深さを容易に測定することができる。

【００３９】さらに、本発明の液体潤滑剤の液面深さ測定方法によれば、レンズを備えた光学機器によって液体潤滑剤の液面深さを測定するので、液体潤滑剤の液面深さを正確に測定することができ、液体潤滑剤の液量を容易に適正な量に管理することができる。

【００４０】したがって、流体軸受装置をスピンドルモータなどに組み込む前に、液体潤滑剤の液量を適正な量に調整することによって、液体潤滑剤の不足による軸受内への空気の巻き込み、摩擦による軸受の焼き付き及び液体潤滑剤の過多による流出を防止することができる。

【００４１】また、請求項６に記載された発明によれば、光学機器として顕微鏡を用いるので、簡便かつ正確に液体潤滑剤の液面深さを測定することができる。

【図面の簡単な説明】

【図１】本発明の一実施の形態における流体軸受装置を示す断面図である。

【図２】本発明の他実施の形態における流体軸受装置を示す断面図である。

【図３】本発明の実施の形態における液体潤滑剤の液面深さ測定方法を示す概略図である。

【図４】図３の要部拡大図である。

【図５】液面深さの示す部分拡大図である。

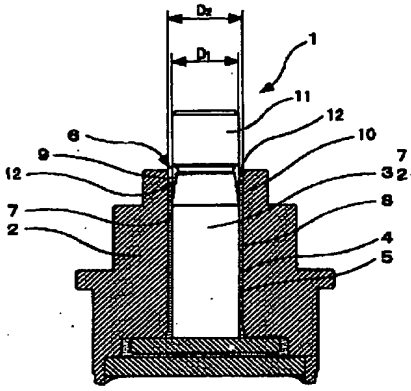
【符号の説明】

１　流体軸受装置
２　スリーブ
３　シャフト
４　微小環状間隙
５　潤滑剤
６　開口部
７　内周面
８　外周面
９　テーパ面
１０　テーパ状環状間隙
１１　突出部
１２　キャピラリシール面
１３　テーパ面
１４　スリーブの端面
１９　リング状封止部材
２０　支持台
２２　顕微鏡
２３　レンズ部
２４　測長ゲージ
３２　液面深さの上限
３３　液面深さの下限
３４　膨張時の液面深さ
３５　減少時の液面深さ
Ｌ　潤滑油の液面深さ
L_1　スリーブ端面の高さ

9　　10

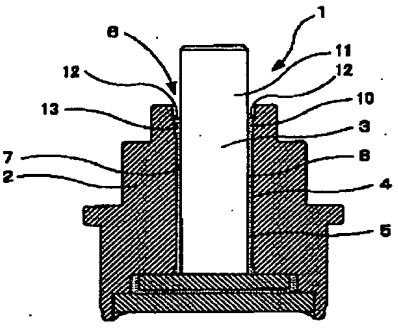
L_2　キャピラリシール面の高さ　　X　支持台の移動方向

【図１】



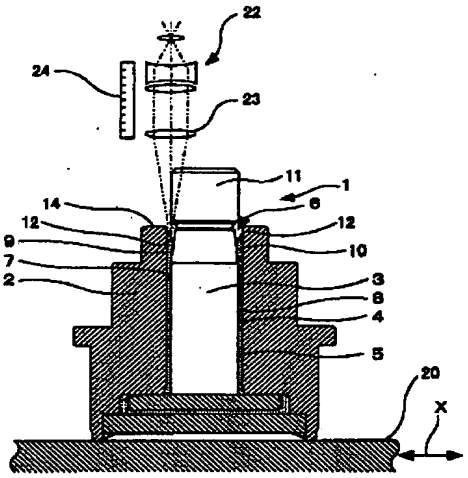
2…スリーブ
3…シャフト
4…微小環状間隙
5…潤滑油
6…スリーブの開口部
9…テーパ面
10…テーパ状環状間隙
12…キャピラリシール面

【図２】



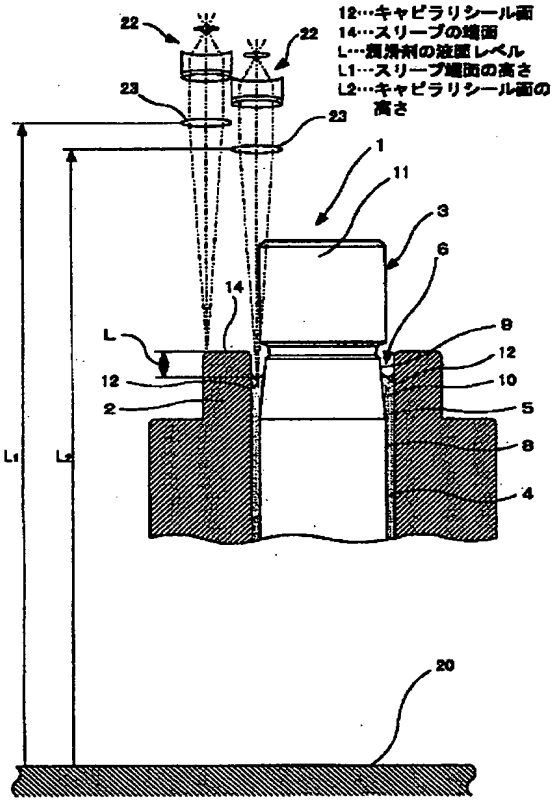
2…スリーブ
3…シャフト
4…微小環状間隙
5…潤滑油
6…スリーブの開口部
10…テーパ状環状間隙
12…キャピラリシール面
13…テーパ面

【図３】



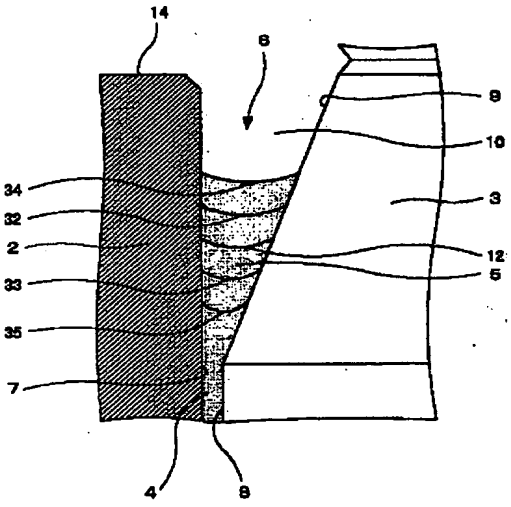
2…スリーブ
3…シャフト
4…微小環状間隙
5…潤滑油
10…テーパ状環状間隙
12…キャピラリシール面
14…スリーブの端面
22…顕微鏡
23…レンズ部
24…測長ゲージ

【図４】



12…キャピラリシール面
14…スリーブの端面
L…潤滑剤の液面レベル
L1…スリーブ端面の高さ
L2…キャピラリシール面の高さ

【図５】



12…キャピラリシール面
32…液面レベルの上限
33…液面レベルの下限

フロントページの続き

Ｆターム(参考)　2F014 AA08 FA10
2F065 AA06 AA25 CC00 FF10 FF61
HH13 JJ03 JJ09 NN20 PP24
QQ25
3J011 AA07 BA02 BA04 BA06 BA08
DA02 EA04 JA02 KA02 KA03
MA01 MA24 PA03 RA01